

Kaufman - Trading Systems & Methods - Chap17

Chap17

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17 Adaptive Techniques

An adaptive technique is one that changes with market conditions. It could be as simple as using a percentage stoploss; however, technicians have begun to associate the idea of "adaptive" with a broader scope, although the purpose remains the same to handle more changing conditions without manual intervention. The trends and indicators that are discussed in this chapter are able to change the calculation period. Under some conditions, such as sideways markets, it may be best to use a slow trend or momentum. and during explosive intervals those same methods are expected to work better if they respond quickly.

ADAPTIVE TREND CALCULATIONS

We begin by looking at techniques that vary the length of the trend. These techniques are based on a common premise that it is better to use a longer term trend, one that is slower to react to price change, when the market is either in a sideways pattern, has low volatility or, in the case of Kaufman, has high relative noise. This may seem a reasonable assumption, but identifying a sideways market is very difficult. A price may be unchanged from a week ago, yet during those 5 days it rose quickly for 3 days, then reversed sharply and, coincidentally, was at the same level on the 5th day, as it continued to plunge. In many ways these adaptive techniques improve the basic performance of standard trend calculations, but they cannot solve all of the problems.

Kaufman's Adaptive Moving Average

Kaufman's Adaptive Moving Average (KAMA), which began taking form in 192, is based on the concept that a noisy market requires a slower trend than one with less noise. That is, the trendline must lag further behind in a relatively noisy market to avoid being penetrated by the price, which would cause a trend change. When prices move consistently in one direction, any trend speed may be used because there are no false changes of direction. The KAMA is intended to use the fastest trend possible, based on the smallest calculation period for the existing market conditions. It varies the speed of the trend by using an exponential smoothing formula, changing the smoothing constant each period. The use of a smoothing constant was selected because it allows for a full range of trends, compared with the simple moving average that uses integer values and is limited in the selection of the trend speeds (see the discussion of exponential smoothing in Chapter 4, Trend Calculations).

$$KAMA_t = KAMA_{t-1} + sc_t \times (\text{Price} - KAMA_{t-1})$$

where $KAMA_t$ is the new adaptive moving average
 $KAMA_{t-1}$ is the previous adaptive moving average
 Price is the current price (for period t)
 sc_t is the smoothing constant, calculated as

⁹See Perry I. Kaufman, *Smarter Trading* (McGrawHill, New York, 1995, pp. 129153) for a complete discussion of this method.

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$$sc_t = [ER_t \times (\text{fastest} - \text{slowest}) + \text{slowest}]$$

and

$$\text{fastest} = 2 / (\text{fastest moving average period})$$

$$\text{slowest} = 2 / (\text{slowest moving average period})$$

$$ER_t = \frac{|\text{price}_t - \text{price}_{t-n}|}{\sum_{i=t-n}^t |\text{price}_i - \text{price}_{i-1}|}$$

The fastest and slowest values represent the range of periods over which KAMA can vary, each converted to its exponential smoothing constant equivalent. Nominally, these values are set to 2 and 30. By squaring the smoothing constant components, the slow end becomes 30 x 30, equal to an extremely unresponsive 900period trend. The effect of this is to stop the movement of the trendline when the market becomes very noisy. On the other end, when the market goes up steadily, without a reversal for n days, the speed of the trend can reach a very fast 4period equivalent.

The efficiency ratio, ER, has more recently been called fractal efficiency. It has the value of 1 when prices move in the same direction for the full n periods, and a value of 0 when prices are unchanged over the n periods. When prices move in wide swings within the interval, the sum of the denominator becomes very large compared with the numerator and ER

approaches 0. Smaller values of ER result in a smaller smoothing constant and a slower trend.

If you choose to use the default values for KAMA, where ER is calculated over 10 periods and the smoothing constant ranges from 2 to 30 (squared), its calculation can be expressed in Omega code as

```
KAMA = KAMA[1] + ((@absvalue(close-close[10])
                    @summation(@absvalue(close-close[1]))
```

Time Period for ER

In Kaufman's Adaptive Moving Average, the time period only affects the calculation of the efficiency ratio. The purpose is to keep that period, n, as small as possible so that the evaluation of a few days will allow the speed of the trend to change from fast to slow and back again. User's may begin testing in the range of 8 to 10 days.

Choice of Volatility

The use of the volatility function, @summation(@absvalue(closeclose[10]),~ in Omega code, adds all the individual price changes rather than looking only at the highlow range. Noise is considered more active when prices jump up and down. It is not as important that prices moved from a particular low to a certain high, but the pattern of how it was done. A market in which prices moved from low to high then back to the low and high again is clearly more volatile and noisier than one that made a single move from low to high.

Small Moves in One Direction

Occasionally there will be a series of price moves that progress in very small increments in one direction without a reversal, causing ER = 1. Although this is theoretically correct, it may prove best to include a filter for those cases where the direction, D = /price, price,, 1 < min, or a scaling function that does not allow the smoothing constant to produce the usual fast trend as the direction D moves below min.

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Trading KAMA

The Adaptive Moving Average can be traded as any trend, and has the same characteristics of exponential smoothing. That is, when prices cross the trendline from up to down, the trendline must turn down. Although KAMA may use a trend with the equivalent of 900 days, the value of the current KAMA will still turn down a very small amount. Trading rules that base signals on the direction of the trendline should include a small band around the KAMA to prevent price penetrations during a sideways market to cause a change in the trading signal. Without this band, the benefit of a sideways KAMA trendline is eliminated.

When applying KAMA to a trading program, it can be seen that higher values of the efficiency ratio, ER, are rarely reached using a calculation period greater than 14. This would require an extremely directional move for 2 weeks of daily data. As longer periods are used, the pattern of ER becomes very uniform, based on the underlying level of noise

in each market. Because peak levels in the ER cannot be sustained, they are valuable candidates for profit taking.

Programming KAMA

The following Easy Language user function can be used by a system or indicator to calculate Kaufman's Adaptive Moving Average.

{KAMA : Kaufman's Adaptive Moving Average

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```
inputs: period(numericsimple);
vars:          efratio(0), smooth(1),
             AMA(0), diff(0), signal(0);

{calculate efficiency ratio}
efratio = 1;
diff = @absvalue(close - close[1]);
if currentbar > period then begin
    signal = @absvalue(close - close[period]);
    noise = @summation(diff,period);
    if noise <> 0 then efratio = signal/noise;
end;
if currentbar <= period then AMA = close;
smooth = @power(efratio*(fastend - slowend));
AMA = AMA[1] + smooth*(close - AMA[1]);
KAMA = AMA;
```

Chande's Variable Index Dynamic Average (VIDYA)

Tushar Chande's Variable Index Dynamic Average (VIDYA) first appeared in Technical Analysis of Stocks & Commodities in March 1992. Both VIDYA and Kaufman's KAMA use an exponential smoothing as a base for varying the speed of the trend each day. VIDYA, however, uses a pivotal smoothing constant, which is fixed, and varies the speed by using a factor based on the relative volatility to increase or decrease the value of s.

$$VIDYA_t = k \times s \times C_t + (1 - k \times s) \times VIDYA_{t-1}$$

where s is a fixed smoothing constant, suggested

(i.e., $s = 2/(9 + 1) = .20$)

C is the closing price

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t and $t - 1$ represent the current

k is the relative volatility, calculated as

$k = @stdev(C, n) / @stdev(C, m)$

where $@stdev$ is the standard deviation

n is the recent past n days

m is a longer historic interval

Volatility

Chande uses a very practical relative volatility measure based on the standard deviation, or distribution of price moves over the past n days, compared with a longer historic pattern, taken over h days. When $k > 1$ the current volatility is greater than the historic volatility; when $k < 1$ the current volatility is lower. VIDYA can be written as an indicator in Omega code as

```
{VIDYA : Variable Index Dynamic Average by Tushar Chande
Copyright 1997-1998, PJ Kaufman. All rights reserved.
Period suggested at 9, histper suggested at > 9}
```

```
input: period(9), histper(30);
```

```
var: k(0), sc(0), VIDYA(0);
```

```
{relative volatility}
```

```
k = @stddev(close, period) / @stddev(close, histper)
```

```
{smoothing constant}
```

```
sc = 2 / (period + 1);
```

```
{VIDYA}
```

```
VIDYA = k*sc*close + (1 - k*sc)*VIDYA[1];
```

```
plot1 (VIDYA, "VIDYA");
```

Alternate Choices for Varying the Trend Period

The use of an exponential formula, either the simplified one shown

by Kauffman or the traditional one of Chande, allows the smoothing constant to vary according to the design of the user. There are indicators with which we are already familiar that might be substituted for the smoothing constant.

Correlation Coefficient, r^2

The most likely choice, suggested by Chande, is the r^2 , the result of measuring the residuals from a linear regression fit is very strong, the value of r^2 is near 1; when r^2 is near 0. This fits neatly into the same pattern of VIDYA.

When programming this technique, the calculation of r , requires the use of arrays and your own code for the formulas found in Chapter 3. To avoid that complexity, I calculate a similar technique (Method 1) by evaluating the correlation coefficient, r^2 , of the series of current residuals and a time series containing the sequential values 1, 2, 3, ... value of the residual based on a linear regression of the residuals. The correlation coefficient, r^2 , of the series of current residuals and the code Method 2 is plotted, and the result of Method 1

```
{Adaptive R2 : Adaptive Correlation Coefficient  
Copyright 1997-1998, PJ Kaufman  
Plot smoothing function based  
on simple time series function
```



```

input: period(9);
var:    R2(0), AR2(0), timeseries(0), resid(0),

timeseries = currentbar;
(Method 1: correlation of price and timeseries)
if currentbar <= period then AR2 = close
    else begin
        R2 = (@correlation(close, timeseries));
        AR2 = AR2[1] + R2*(close - AR2[1]);
    end;
{ plot1 (AR2,"R2");}
(Method 2: correlation with current regression residual)
resid = close - @linearregvalue(close,period,0)
RR2 = (@correlation(resid, timeseries, period));
ARR2 = ARR2[1] + RR2*(close - ARR2[1]);
plot2 (ARR2,"ARR2");

```

Momentum Calculations

There are many momentum calculations, such as RSI, that vary from 0 to 1, or from 1 to +1. In most cases the trend is considered strongest when the momentum value is closest to the extremes. The momentum values can easily be changed to fit the 0to1 pattern of the smoothing constant by using the transformations

- | | |
|-----------------------------|------------------------------|
| (1) For a range of 0 to 1 | $sc = @absvalue(M - .5) * 2$ |
| (2) For a range of -1 to +1 | $sc = @absvalue(M)$ |

where sc is the smoothing constant to be used for the current trend and M is the current momentum value

By reflecting the lower extreme around the midpoint of the current trend, the absolute value, the transformed indicator shows a stronger trend near 0.

Programming the Adaptive RSI

The following Omega code adapts the RSI to a smooth

```
{Adaptive RSI : Adaptive Relative Strength Indicator  
Smoothing function based on RSI}
```

```
input:  period(20);  
var:    sc(0), ARSI(0);  
  
if currentbar <= period then ARSI = close  
    else begin  
        sc = (@absvalue(@RSI(close  
        ARSI = ARSI[1] + sc*(close  
        end;  
plot1 (ARSI, "ARSI");
```

Comparison of Adaptive Trends

Figure 171 shows three of the adaptive trending methods compared with a moving average, all based on a base calculation period of 20. Kaufman's KAMA appears to be slightly closer to prices than Chande's VIDYA and flattens out faster during sideways periods; otherwise, they have similar characteristics because they both use the structure of the exponential smoothing calculation. The adaptive RSI (ARSI), used as a substitute for the smoothing constant, is most responsive to price and appears as though it moves through the center of many of the sideways periods. Because the ARSI is much faster, it tends to get caught with a

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false signal at the end of each sustained price move. The 20period moving average is reasonably smooth during this market segment and shows typical characteristics of lag. When constructing trading rules for any of these methods, the buy and sell signals are best if taken as the direction of the trendline and not a price penetration of the trendline.

McKinley Dynamics'

Among the work produced by John McGinley is a list of popular adaptive methods. His own New McGinley Dynamics is included:

where MD is the current McGinley Dynamic
MD[1] is the previous McGinley Dynamic
k is a constant = .60 (60% of a selected moving average)
p is the moving average period
close is the closing price

The first wellknown adaptive technique was the Parabolic Time/Price System,' which attempts to reduce the lag intrinsic to a trend system. To do this, Wilder increased the speed of the trend by shortening the number of days in the calculation, whenever prices reached new profit levels. The philosophy of the Parabolic System is that time is an enemy. Once a position is entered, it must continue to be profitable or it will be liquidated.

4 j. Welles Wilder, Jr., *New Concepts in TecAmical Trading Systems* (Trend Research, Greensboro, NC, 198).

Swiss Franc - CME-Daily

02/20/96 C=85.0300 +5500 O=85.2500 H=85.2800 L=84.4800 AMA 83.4018 Mov Avg 1 line

ARSI

MA

VIDYA

MA

KAMA

ARSI

Sep Oct Nov Dec 96 Feb

The Parabolic Time/Price System is always in the market; whenever a position is closed out, it is also reversed. The point at which this occurs is called the Stop and Reverse (SAR). When plotted, the Stop and Reverse point seems similar to a trendline, although it has a decreasing lag (the distance between the current price and the trendline, or SAR point, get closer each period), as shown in Figure 172. During periods of short, consistent trending, the Parabolic SAR converges on the price trend, extracting excellent profits.

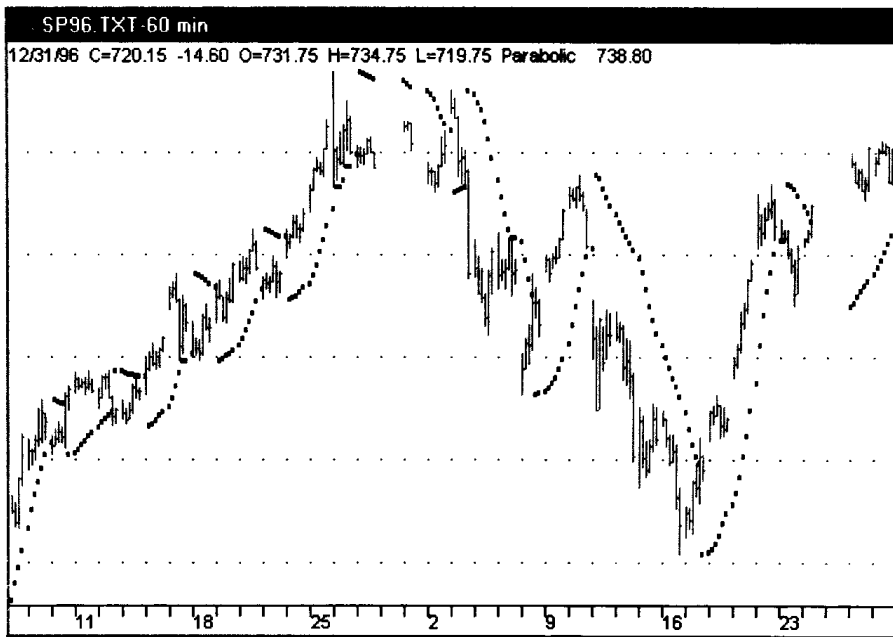
To calculate the SAR value, first assume a long or short position. If the market has recently moved lower and is now above the lows of that move, assume a long. Call the lowest point of the previous trade the SAR initial point (SIP) because it will be the starting point for the SAR calculation ($SAR_i = SIP$). Calculate each following SAR as $SAR(\text{today}) = SAR(\text{prior}) + AF(\text{today}) \times [High(\text{today}) - SAR(\text{prior})]$

This is an exponential smoothing formula using the high price for a long position and the low when a short is held. For this method the smoothing constant is called the acceleration factor (AF), and it is initially set to .02 at the beginning of each trade. After a day in which a new extreme occurs (a new high when long, or a new low when short), the AF is increased by .02. In terms of moving average days, the AF begins at 99 days and increases speed to a maximum of a 9day moving average, but not in a linear fashion. The acceleration factor, AF, cannot be increased above the value .20.

In the SAR calculation, the highest high of the current move is used when a long position is held, and the lowest low is used when a short is held. This feature keeps the SAR at its highest possible level during an upward move. An additional rule compensates for this strength and prevents premature reversal by not allowing the SAR to get any closer than the price range of the most recent 2 days:

If long, the SAR may never be greater than the low of today or the prior day. If it is greater than this low, set the SAR to that low value. A reversal will occur on a new intraday low that penetrates the SAR.

FIGURE 172 Parabolic Time/Price System, Feb 96 S&P 500, 60minute chart.



Source: Chart created with *TradeStation®* by Omega Research, Inc.

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For short positions, the SAR is initialized as the high of the recent move, $AF = .02$, and the daily calculation uses the lowest low of the current price move. To allow some price fluctuation, the SAR may never be below the high of today or the prior day.

Wilder's Parabolic Time/Price System was unique in varying the smoothing constant to satisfy the notion that time worked against the trade. The idea of increasing the speed of the trend as the trade becomes more profitable is still a concept that has validity and has not been adopted in other adaptive methods. One weak point may be that AF always begins at $.02$. Although this allows the trade latitude to develop without being stopped out, a market that is moving quickly through the buy or sell signal would be better traded with a faster trend. This method also requires fairly consistent price swings to produce profits.

A strong point is that the initial Stop and Reversal is the market extreme high or low rather than an arbitrary, computer-generated point. Also, the SAR does not get closer than the previous day's high or low, which prevents a reversal when the market is moving strongly in a profitable direction. For those readers interested in the further development of this method, the Parabolic Time/Price System is combined with Directional Movement (described in Chapter 23) to form the Directional Parabolic System discussed in Chapter 6.

The following Easy Language user function allows the user to

specify the starting value of the smoothing constant $A F_{min}$, the increment $A F_{inc}$, and the maximum value $A F_{max}$. This provides for more flexible testing. Optimization of these values has been reported to produce good results.

{Parabolic.VRT

This version of the Parabolic system was written by
Sam Tennis, VISTA Research and Trading, Inc.,
8103 Camino Real, South Miami, FL 33143, Email: skt
and reformatted by PJ Kaufman}

{Input values were formerly AFmin = AFactor, AFincl =

{Sample usage: Plot1 (Parabolic.VRT (0.02, 0.02, 0.2

Function returns SAR (stop & reverse) price objecti

input: AFmin(numeric), AFincl(numeric)

vars: Position(1), AF(AFmin), SAR(low[0]),

if @currentbar <= 1 then Position = 1;

if @currentbar > 1 then begin

if High > Hi then Hi = High;

if Low < Lo then Lo = Low;

if Position = 1 then begin

if Low <= SAR[1] then begin

Position = -1;

SAR = Hi;

AF + 3 = AFmin;

Lo = Low;

Hi = High;

end; {Reverse position}

end

else begin

if High >= SAR[1] then begin

Position = 1;

SAR = Lo;

AF = AFmin;

Lo = Low;

Hi = High;

end; {Reverse position}

```

        end;
    end;
    if Position = 1 then begin
        if Position[1] = 1 then begin
            SAR = SAR[1] + AF * (High[1] - SAR[1]);
            if Hi > Hi[1] and AF < AFmax then AF =
                end; {we have been "long" for at least
            if SAR > Low then SAR = Low;
            if SAR > Low[1] then SAR = Low[1];
            end {long}
        else begin
            if Position[1] = -1 then begin
                SAR = SAR[1] + AF * (Low[1] -
                if Lo < Lo[1] and AF < AFmax t
                end; {we have been "short" for
            if SAR < High then SAR = High;
            if SAR < High[1] then SAR = High[1];
            end; {short}
        end;
    end;
    Parabolic.VRT = SAR;

```

The MasterTrading Formula

Another landmark method of creating a variablespeed approach is Mart's Master Trading Formula.' It is also based on an exponential smoothing formula where the smoothing constant and band around the trendline are calculated daily, based on market volatility. Mart's general technique is to combine the average true range (the maximum of yesterday's close and today's high or low) for the past 15 days with the net change over the same time period. Each of these volatility elements is ranked from 1 to 21 by defining a maximum value for each one and dividing that maximum into 20 equal zones (the 21st being anything higher). The two rankings are then averaged to get a correlated volatility factor (CVF). Another ranking of 21 zones is created by dividing the highest CVF into 20 equal parts. The CVF then relates linearly to a range of smoothing constants from .084 to .330, representing the approximate exponential equivalents of the moving average days from 5 to 23. The trendline value is then created daily using the formula

$$\text{TREND}(\text{today}) = \text{TREND}(\text{prior}) + \text{CVF}(\text{today}) \times [\text{HLC}(\text{today}) - \text{TREND}(\text{Prior})]$$

where HLC (today) is the average of the high, low, and closing price. As with the other adaptive methods, the speed of the trend increases as volatility increases.

A band is also placed around the trendline, based on an inverse relationship to the correlated volatility factor. The band is widest when there is low volatility and the smoothing constant produces a slow trend; it is narrowest in fast, highly volatile markets. Rules for trading Mart's Master Formula follow the basic bandtrading rules. The system is always in the market, taking long positions when the upper band is broken and short positions when the lower band is crossed.

ADAPTIVE MOMENTUM CALCULATIONS

Varying the period of calculation does not have to be limited to a trend formula. The period for any technique can also be adaptive. The following techniques apply the same concept to indicators.

1 Donald Mart, *Me Master Trading Formula* (Winsor Books, Brightwaters, NY 1981).

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VariableLength Stochastic

Written by Frank Key,' this adaptive technique uses Kaufman's efficiency ratio, ER. It changes the stochastic period within the default range of 5 to 30, using only integer values. The effect is that, when prices are trending with respect to the stochastic, the stochastic period is lengthened to allow the trading signal to stay with the trade. At turning points in the market, the stochastic period is shortened causing the reversal signal to be more responsive.

Stochastic period

$$NSP = @IntPortion(ER \times (Maxperiod - Minperiod) + Minperiod)$$

Adaptive stochastic

$$ASTOK = @slowK(NSP)$$

where ASTOK is the adaptive stochastic value today (based on today's closing price)

Maxperiod is the maximum period, suggested as 30

Minperiod is minimum period, suggested as 5

ER is Kaufman's efficiency ratio

The variablelength stochastic uses the efficiency ratio in a manner opposite to Kaufman's AMA. While the AMA increases in speed when the trend gets stronger, Key's variablelength stochastic decreases in speed. This technique gives price more room to fluctuate during periods in which a strong trend is also associated with high volatility

TrendAdjusted Oscillator

One problem that confronts many traders who use stochastics or other oscillators is that the oscillator values tend to cluster at the bottom of the chart when the trend is down, and at the top when the trend is up. For a countertrend trader, this results in many oversold conditions during a downtrend, which can give false buy signals. A trendadjusted oscillator 7

can help this bias by correcting the value of the oscillator by the amount that the trend of the oscillator varies from its midpoint (usually 50%). Therefore, if a 10day oscillator has been steadily declining and its 5day moving average has a value of 40, then the current oscillator value is raised by 10% (the midpoint of 50 minus the oscillator moving average of 40). The calculations for this are:

$$n\text{-day oscillator} = O = \frac{\sum_{i=t-n+1}^t (Close_i - Low_i) / (High_i - Low_i)}{n}$$

$$N\text{-day moving average of oscillator} = MA_O = \frac{\sum_{i=t-N+1}^t O_i}{N}$$

$$Trend\text{-adjusted oscillator} = Midpoint - (MA_O - O)$$

⁶ Frank Key, Structured Software Systems, Mt. Holly, NJ. Copyright 1996.

⁷ E. Marshall Wall, "Rolling with the punches," *Futures* (July 1996).

Dynamic Momentum Index

This approach to creating a dynamic, variablelength RSI, which changes the number of days based on market volatility, can be used to change the calculation period of any technique.⁶ In the Dynamic Momentum Index (DMI), the length of the calculation period increases as the volatility declines. You may also select a pivotal period, one around which the calculation period will vary; for the RSI this will be 14 days. When the volatility increases, the periods will be less than 14 days and when volatility declines it will be greater. Based on this,

$$\text{DMI} = @Int\left(\frac{14}{\text{volatility}_t}\right)$$

$$\text{volatility}_t = \frac{@stdev(\text{close}, 5)}{@avg(@stdev(\text{close}, 5), 10)}$$

The DMI is 14, the pivotal value, when the volatility is normal; that is, when the current 5day standard deviation is the same as the 10day average of the 5day standard deviation. When the current volatility increases, the ratio is greater than 1 and the value of the DMI becomes larger than 14. The function @Int takes the integer value of the calculation to be used as the number of days in the RSI calculation.

A few changes in the DMI approach may improve results and should be considered when generalizing this technique. First, the standard deviation should always be applied to the changes in price, rather than the prices themselves. This removes the trend component. Alternately, the volatility ratio may be more robust if the sum of the absolute value of the price changes is simply compared against the average of that sum,

$$\text{volatility}_t = \frac{@sum(@absvalue(\text{cl})){@avg(@sum(@absvalue(\text{cl})))}$$

AN ADAPTIVE PROCESS

An adaptive method can be a process as well as a formula. Rather than using an index or ratio to change the smoothing constant, which in turn alters the trend speed to be in tune with the current market, you can retest your system regularly using more recent data. The period being retested can always be a fixed number of days, or it can be selected visually, beginning when the market changed its pattern, became more volatile, underwent a price shock, or moved to new highs or lows. The problem is having enough data to be satisfied that the results are dependable; the faster you react, the less data there is to make a decision. This approach, along with other testing methods, are covered in detail in Chapter 21 ("Testing").

A Development Example

The size of price changes can also be used to vary the period of a moving average. When prices become more volatile, as measured by the standard deviation of the price changes, a shorter period can be used to follow the market more closely. When there are smaller price changes, or

stable volatility, the preference is to slow the trend by increasing the calculation period.' The following steps can be used to build and personalize a variable speed moving average:

⁷Tushar Chande and Stanley Kroll, *The New Market Technician* (John Wiley & Sons, New York, 1994).

⁸George R. Arrington, "Building a Variable Length Moving Average," *Tecimical Analysis of Stocks & Commodities* (June 1991).

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1. Select the range over which the period of the moving average may fluctuate. For example, a medium to fast program might range from 5 to 30 days.
2. Calculate the mean and standard deviation of price changes over a separate, fixed time period, recommended as the length of the longest trend period (in this case, 30 days), but enough days to have a reasonable sample (no less than 10 days). Using a smaller period reduces the response time needed to switch from one moving average speed to another, but causes the results to be more erratic.
- 3 Select zones, or threshold levels, at which the market is seen to be relatively more active or less active. For example, within the boundary of the mean + .25 standard deviations, we will define a low volatility, less active area where the longest period would be used. Outside the boundary of the mean $\pm$ 1.75 standard deviations would be an unusual, highly active market requiring a fast trend.
4. Establish the rate at which the moving average period would change as volatility (price change) increases from the inside to outside boundary. This could be the linear relationship

$$n_t = (30 - 5) * ((P_t - P_{t-1})/\text{stdev} - .25)/(1.75 - .25) \\ \text{for } 1.75 > (P_t - P_{t-1})/\text{stdev} > .25$$

when $(P_t - P_{t-1})/\text{stdev}$ is between 1.75 and .25. Otherwise, 30 and 5, respectively. The general form is

$$\text{today's moving average period} = (\text{max ma period} \\ (\text{today's change/stdev of changes} - \text{min stdev} \\ \text{boundary} - \text{min stdev boundary}) + \text{min mov}$$

CONSIDERING ADAPTIVE METHODS

At first glance, there appears to be a conflict between the sound statistical approach that encourages the choice of a simple set of rules applied to a long period of test data and adaptive methods. The classic result is a statistically robust model, but one that might show considerable variation in performance over the test period. To stabilize returns we move away from fixed values in trading systems, such as a \$500 stoploss, or a 50point breakout, and substitute risk and entry criteria that are based on volatility. The simplest of these methods uses a percentage of price; the

most complex can be very intricate functions of volatility and cycles.

When a variable feature is incorporated into the strategy, the values should smoothly adjust to the market patterns, but each case, such as extreme high or low volatility, has fewer occurrences; therefore, we are not as certain that the sliding scale works at all levels. The best we can expect is that the technique has a sound premise, is well defined, and the profile of performance is improved.

If we follow that logic further, we eventually come to the adaptive, or selfadjusting method, in which the most fundamental elements of a calculation can vary based on price level, volatility, or a broad choice of patterns. The methods in this chapter focused on two areas that have not been presented elsewhere in a collected manner. The first is the variation of the trend period itself. The choice of a single trend does not serve us best for prolonged periods in the market. Slower trends are reliable, but give back much of their profits before ending; faster trends work only during periods when prices move quickly and uniformly. The obvious solution is that the calculation period should change, speeding up when there is a shortterm, fastmoving price pattern. At other times, it should focus on the longterm direction. This concept is perfectly reasonable, although formulating the rules to vary the period has not been perfected. The methods shown here may

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work better than a static period, but should only be the beginning of a road on which to move forward.

The other adaptive method is the centering of an oscillator to avoid prolonged periods in which the value of the indicator loses significance by pushing against the upper or lower limits. By recording the high and low values of a past time interval, the oscillator values can be continually readjusted to provide a more useful tool. Analysts are encouraged to look further into these methods as an excellent way to improve system robustness.